

CLAIMS

1. A method of transferring a particle between manifolds of optical traps, comprising the steps of:

providing a beam of laser light;

dividing the beam of laser light into a plurality of additional beams of laser light;

focusing the additional beams of laser light to establish a plurality of optical traps;

providing first, second, and third patterns including a plurality of sequentially spaced manifolds, each manifold comprising at least one optical trap from the beams of laser light with the first, second, and third patterns arranged such that the manifolds comprising each pattern are separated by a manifold of each of the other patterns; and

sequentially illuminating and extinguishing each of the patterns using the beams of laser light at intervals close enough after the extinguishing of the previous pattern to capture and transfer the particle from one manifold to the adjacent manifold, wherein the capture and transfer of the particle causes the particle to travel from the one manifold on the one pattern to the next adjacent manifold on the same pattern.

2. The method of claim 1, wherein the manifolds of each of the patterns are aligned substantially parallel to each other, and wherein the particle travels along a substantially linear trajectory normal to the manifolds of each of the patterns.

3. The method of claim 1, wherein the manifolds of each of the patterns include a radius of curvature, and wherein the particle travels along a trajectory substantially towards the center of curvature of each of the manifolds.

4. The method of claim 1, wherein a plurality of particles are transferred across each of the manifolds.

5. The method of claim 4, wherein the each of the manifolds are concentrically arranged so as to concentrate the plurality of particles in a particular region or disperse the plurality of particles away from a particular region.
6. The method of claim 4, further comprising the step of applying an external field to each of the plurality of particles, wherein the sequential illumination and extinguishment of each of the patterns using the beams of laser light alters the direction of at least some of the particles relative to the direction that the particles would have taken solely in the presence of the external field.
7. The method of claim 6, wherein the applied field operates so as to not alter the direction of at least some of the particles as they travel from the one manifold to the next immediately adjacent manifold.
8. The method of claim 4, wherein the particle is part of a mass that is larger than the physical separation between the individual optical traps on each of the manifolds, and wherein the movement of the particle from the one manifold to the next immediately adjacent manifold results in a physical deformation of the mass.
9. The method of claim 4, wherein the particle is part of a mass that is larger than the physical separation between the individual optical traps on each manifold, and wherein the movement of the particle from one manifold to the next immediately adjacent manifold results in a physical rotation of the mass.
10. The method of claim 1, wherein the particle comprises part of a biological medium.
11. A method of manipulating a plurality of particles using a beam of laser light, comprising the steps of:
 - providing a beam of laser light;
 - dividing the beam of laser light into a plurality of additional beams of laser light;

focusing the additional beams of laser light to establish a plurality of optical traps;
providing a plurality of interwoven patterns each comprising at least one manifold, each manifold including at least one optical trap with the beams of laser light and located adjacent to manifolds of other patterns;

sequentially illuminating and extinguishing each pattern using the beams of light at intervals close enough after the extinguishing of the previous pattern to capture a particle in the plurality of particles, wherein the particle travels from a manifold on one pattern to the next adjacent manifold.

12. The method of claim 11, wherein the plurality of particles comprise at least a portion of a biological medium.

13. The method of claim 11, wherein the plurality of particles is larger than the physical separation between the individual optical traps on each of the manifolds, and wherein the movement of the particle across each of the manifolds results in a physical rotation of the plurality of particles.

14. The method of claim 11, wherein the plurality of particles is larger than the physical separation between the individual optical traps on each of the manifolds, and wherein the movement of each particle across each of the manifolds results in a physical deformation of the plurality of particles.

15. The method of claim 11, wherein each of the manifolds are aligned substantially parallel to each other, and wherein the plurality of particles travel along a substantially linear trajectory normal to the each of the manifolds.

16. The method of claim 11, wherein the each of the manifolds include a radius of curvature, and wherein the plurality of particles travel along a trajectory substantially towards the center of curvature of each manifold.

17. An apparatus for manipulating a plurality of particles, comprising:
a beam of laser light divided into a plurality of additional beams of laser light, the
additional beams of laser light establishing a plurality of optical traps;
first, second, and third patterns including a plurality of sequentially spaced manifolds,
each of the manifolds comprising an optical trap formed from the beams of laser light, the
first, second, and third patterns arranged such that the manifolds of each of the patterns are
separated by a manifold of each of the other patterns; and
means for sequentially illuminating and extinguishing each pattern using the beams of
light at intervals close enough after the extinguishing of the previous pattern captures and
transfers a particle from one manifold to the next adjacent manifold, and wherein the capture
and transfer of the particle causes the particle to travel from the one manifold on the first
pattern to the next manifold of the same pattern.

18. The apparatus of claim 17, wherein the particle is part of a plurality of particles that is
larger than the physical separation between the individual optical traps on each of the
manifolds, and wherein the movement of the particle from the one manifold to the next
immediately adjacent manifold results in a physical deformation of the plurality of particles.

19. The apparatus of claim 17, wherein the particle is part of a plurality of particles that is
larger than the physical separation between the individual optical traps on each of the
manifolds, and wherein the movement of the particle from the one manifold to the next
immediately adjacent manifold results in a physical rotation of the plurality of particles.

20. The apparatus of claim 17, wherein the direction of the particle as it travels from the
one manifold to the next immediately adjacent manifold is altered by the application of an
external field to the particle.

21. The apparatus of claim 17, wherein the direction of the particle as it travels from the
one manifold to the next immediately adjacent manifold is not altered by the application of an
external field to the particle.

22. The apparatus of claim 17, wherein the particle comprises a portion of a biological medium.

23. The apparatus of claim 17, wherein the manifolds of each of the patterns are aligned substantially parallel to each other, and wherein the particle travels along a substantially linear trajectory normal to the manifolds of each pattern.

24. The apparatus of claim 17, wherein the manifolds of each pattern include a radius of curvature, and wherein the particle travels along a trajectory substantially towards the center of curvature of each manifold.

25. The apparatus of claim 17, wherein the plurality of manifolds are arranged such that the sequential illumination and extinguishing of each pattern separates the plurality of particles into at least two groups of particles.

26. The apparatus of claim 17, wherein the plurality of manifolds are arranged such that the sequential illumination and extinguishing of each pattern combines the plurality of particles into a single group of particles.

27. A method of transferring a plurality of particles between manifolds of deterministic optical gradients, comprising the steps of:

- providing a beam of laser light;
- focusing the laser light to establish a plurality of deterministic optical gradients;
- providing first, second, and third patterns including a plurality of sequentially spaced manifolds, each manifold comprising at least one optical gradient from the laser light with the first, second, and third patterns arranged such that the manifolds comprising each pattern are separated by a manifold of each of the other patterns; and
- sequentially illuminating and extinguishing each of the patterns using the laser light at intervals close enough after the extinguishing of the previous pattern to capture and transfer

individual particles from one manifold to the adjacent manifold, wherein the capture and transfer of each particle causes each particle to travel from the one manifold on the one pattern to the next adjacent manifold on the same pattern.

28. The method of claim 27, wherein the plurality of particles is larger than the physical separation between the individual optical gradients on each of the manifolds, and wherein the movement of the particle across each of the manifolds results in a physical rotation of the plurality of particles.

29. The method of claim 27, wherein the plurality of particles is larger than the physical separation between the individual optical gradients on each of the manifolds, and wherein the movement of each particle across each of the manifolds results in a physical deformation of the plurality of particles.

30. The apparatus of claim 27, wherein the plurality of manifolds are arranged such that the sequential illumination and extinguishing of each pattern separates the plurality of particles into at least two groups of particles.

31. The apparatus of claim 27, wherein the plurality of manifolds are arranged such that the sequential illumination and extinguishing of each pattern combines the plurality of particles into a single group of particles.

32. The method of claim 27, wherein the direction of at least a portion of the plurality of particles as they travel from the one manifold to the next immediately adjacent manifold is altered by the application of an external field.

33. The method of claim 32, wherein the direction of at least a portion of the plurality of particles as they travel from the one manifold to the next immediately adjacent manifold is not altered by the application of an external field.

34. The method of claim 27, wherein at least one of the plurality of deterministic optical gradients comprise an optical trap.